GENETICS
Pre-AP Seventh Grade Science
2011-2012

Description

Organisms can reproduce sexually (eukaryotes) and asexually (prokaryotes). Sexual reproduction requires two parents who both provide genes to the new organism during fertilization, resulting in offspring with a mix of inherited genes. In asexual reproduction, only one parent is needed, and offspring are genetically identical to the parent. In both cases, the genetic instructions necessary for development of offspring are contained inside the cell. This genetic material is responsible for the traits passed on to offspring. These ideas of heredity, or the passing of traits from parent to offspring, were first developed by the father of genetics, Gregor Mendel. Chromosomes, found in the nucleus of eukaryotic cells, are made up of genes, which in turn are made up of DNA, or deoxyribonucleic acid. The information in DNA is a code made up of four chemical bases, and the order of these bases is what determines how an organism grows and develops. DNA is arranged in two strips that form a spiral called a double helix, first discovered through the combined efforts of Rosalind Franklin, James Watson and Francis Crick. An important property of DNA is that it has the ability to make copies of itself. This is important when cells divide because each new cell needs to have an exact copy of the DNA from the old cell. Emphasis is placed on the passing of traits from parent to offspring through replication of DNA during both asexual and sexual reproduction, predicting the diversity of offspring, and problems encountered when that DNA is miscopied. Emphasis is also placed on modeling DNA structure and replication.

Connections

Almost every cell in every living organism contains genetic material. The genetic code passed on by the parent determines the diversity of the offspring. Diversity makes it possible for organisms to grow and thrive in a variety of environments under a multitude of varying conditions. Later units will emphasize adaptations of organisms that make it best suited to living in particular ecosystems and biomes, as well as how these adaptations arise over many generations due to patterns of gene frequency and the process of natural selection.

Enduring Understandings

1. Organisms can be divided into two groups, prokaryotes (without a nucleus) and eukaryotes (with a nucleus),
2. Organisms can reproduce asexually (prokaryotes) and sexually (eukaryotes).
3. During reproduction, genetic instructions are copied and passed on to offspring.
4. DNA is ultimately responsible for the traits passed on to offspring.
5. Dominance determines phenotypes of the offspring. A phenotype is the outward expression of a trait.
6. Gregor Mendel is the father of genetics, and developed the Laws of Heredity.
7. DNA was discovered by James Watson and Francis Crick based on the studies of Rosalind Franklin.
8. Mitosis produces identical cells, while meiosis produces unique cells. Crossover during the prophase I stage of meiosis helps to ensure diversity of organisms that sexually reproduce by producing cells that vary; in addition, meiosis produces haploid cells.
9. Genetic mutations occur when DNA is altered during replication. DNA sequences may be inserted into an existing DNA strand, deleted from an existing DNA strand, or one sequence may be substituted for another in an existing DNA strand, all of which result in a variance of traits.

Essential Questions

1. What are the similarities and differences between prokaryotes and eukaryotes?
2. What are the similarities and differences between sexual and asexual reproduction?
3. How are traits passed on from parent to offspring?
4. Why do some traits show up more often than others?
5. How are some traits combined to produce new traits?
6. How does the process of meiosis help ensure genetic diversity?
7. What constitutes genetic material and how is it formed?
8. What is a genetic mutation and how does it contribute to diversity?
9. Who are the major contributors to the discovery of concepts related to genetics?

Essential Concepts and Skills

By the end of the unit, the student is expected to:

1. Compare and contrast prokaryotes and eukaryotes.
2. Compare and contrast asexual reproduction and sexual reproduction in both plants and animals.
3. Analyze the methods by which genetic material is reproduced and passed on to offspring.
4. Illustrate that chromosomes may be broken down into genes which are made up of DNA.
5. Explain the Laws of Heredity as proposed by Gregor Mendel.
6. Generate proof that some traits are dominant and some are recessive.
7. Predict the probability that certain traits will be present in offspring
8. Describe co-dominance and incomplete dominance.
9. Demonstrate the processes of mitosis and meiosis.
10. Justify why meiosis ensures diversity.
11. Model DNA's double helix and assess why its structure enhances its function.
12. Illustrate that DNA is formed from chemical base pairs which are attached to sugar and phosphate molecules to form nucleotides.
13. Distinguish between insertion, deletion, and substitution during DNA replication, and appraise the effects of subsequent mutations.
14. Evaluate the contributions of Gregor Mendel, Rosalind Franklin, James Watson, and Francis Crick to the field of genetics.

What do students typically have as misconceptions?

A) Daughters inherit most characteristics from their mothers, and boys inherit most from their fathers.
B) Sexual reproduction occurs in animals but not in plants.
C) Alleles and genes are the same thing.
D) Each box in a Punnett square represents a trait of one offspring, rather than a probability that the trait will show up.
E) DNA, genes, and chromosomes are separate structures inside the cell.

Preconception Survey

1. Why do children look like their parents?
2. How can a child have red hair, when neither parent has red hair?
3. What is DNA and where is it found?
4. How do plants reproduce?

Formative Assessment Items

1. Use microscopic models to distinguish between prokaryotes and eukaryotes

2. Use microscopic models to distinguish between mitosis and meiosis.
3. Use a DNA model to demonstrate replication, as well as insertion, deletion, and substitution.
4. Predict traits of offspring using Punnett Squares.
5. Grow three generations of plants in order to identify patterns of inheritance. (Wisconsin Fastplants)

TEKS Covered

7.14 Organisms and environments. The student knows that reproduction is a characteristic of living organisms and that the instructions for traits are governed in the genetic material. The student is expected to:

A) define heredity as the passage of genetic instructions from one generation to the next generation.

B) compare the results of uniform or diverse offspring from sexual reproduction or asexual reproduction. ***Supporting Standard-Category 4***

C) recognize that inherited traits of individuals are governed in the genetic material found in the genes within chromosomes in the nucleus. ***Supporting Standard-Category 4***

College Board Standards Covered

LSM-PE.5.1.1 Describe the problem or scientific question that various scientists investigated and the scientists' contributions to the development of the model of inheritance toward modern genetics. *[**BOUNDARY:** It is suggested that students study Mendel, Watson and Crick, and Franklin; students can, but do not have to, study Sutton and Bateson.]*

LSM-PE.5.1.2 Observe patterns (similar to those observed by Mendel), using data from parent–generation crosses, in traits of parents and offspring.

LSM-PE.5.1.3 Give examples of various scientists whose ideas built upon and/or revised Mendel's model of inheritance.

LSM-PE.5.2.1 Evaluate consistency and accuracy of representations illustrating the major components of the Watson–Crick double-helix model of DNA.

LSM-PE.5.2.2 Construct a representation of DNA replication, showing how the helical DNA molecule unzips and how nucleotide bases pair with the DNA template to form a duplicate of the DNA molecule.

LSM-PE.5.2.3 Construct a representation that shows what happens to the chromosomes of the parent organisms during both the process of fertilization and the first stages of cell division of a zygote.

LSM-PE.5.2.4 Explain and justify, using representations, why the DNA of the daughter cells of asexually reproducing
organisms are identical to the DNA of parent cells. Explanation and justification are based on knowledge of the mechanisms (e.g., asexual reproduction, DNA replication) of DNA transmission from generation to generation in asexually reproducing organisms.

LSM-PE.5.2.5 Explain and justify why the DNA of the offspring of sexually reproducing organisms are not identical to the DNA of either parent organism. Explanation and justification are based on knowledge of the mechanisms (e.g., fertilization, cell division) of DNA transfer between generations in sexually reproducing organisms.

LSM-PE.5.4.1 Describe three ways (e.g., insertion, deletion or substitution) that changes in DNA (mutations) can occur during replication.

LSM-PE.5.4.2 Predict and justify, based on the type of cell, whether a particular error in copying DNA during replication will be transmitted to the offspring.

Vocabulary

dominance, fertilization, sexual reproduction, asexual reproduction, inherit, heredity, diversity, Gregor Mendel, Rosalind Franklin, James Watson, Francis Crick, chromosomes, nucleus, DNA, double-helix model, deoxyribonucleic acid, reproduction, alleles, genes, phenotypes, genotypes, dominant, recessive, Punnett Square, co-dominance, incomplete dominance, prokaryotic, eukaryotic, Laws of Heredity, meiosis, mitosis, mutation